DOCUMENT RESUME

ED 333 973 PS 019 599

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TITLE The Carolina Abecedarian Project.
PUB DATE Apr 91
NOTE 26p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (Seattle, WA, April 18-20, 1991).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Comparative Analysis; *Compensatory Education; Elementary Education; *Elementary School Students; Followup Studies; Grade 7; *Intelligence Quotient; *Preschool Education; *Program Effectiveness; Program Evaluation
IDENTIFIERS *Carolina Abecedarian Project NC

ABSTRACT

A follow-up study of participants in the Carolina Abecedarian Project (CAP) was conducted for the purpose of assessing the long-term efficacy of the preschool intervention. The CAP was a longitudinal study designed to determine the extent to which intensive educational intervention begun in early infancy could prevent developmental retardation and academic failure in children from socioeconomically disadvantaged backgrounds. The follow-up study was conducted four years after intervention had ended, when subjects had completed seven years in public school and were about 12 years old. In total, 90 of the 93 subjects who took part in the earlier phases of intervention were available for follow-up testing. Standardized tests of intellectual ability and academic achievement were individually administered to all subjects in the summer after their seventh school year by examiners who were unaware of the students' intervention history. Findings on the long-range outcomes of the preschool intervention are reported and discussed. (RH)

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The Carolina Abecedarian Project

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Paper presented in M. Burchinal (Chair) Early Experience and Children's Competencies: New Findings from Four Longitudinal Studies. Symposium presented at the meeting of the Society for Research in Child Development, Seattle, Washington, April, 1991.

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The Carolina Abecedarian Project

The Carolina Abecedarian Project was a longitudinal experimental study designed to determine the extent to which intensive educational intervention, begun in early infancy, could prevent developmental retardation and academic failure in children from socioeconomically disadvantaged backgrounds.

Because the majority of cases of Mild Mental Retardation (i.e., IQs between 70 and 55) have no known biological or disease-related cause, the implication is that an environment impoverished in intellectual stimulation contributes to the development of the condition. It follows that an intervention which enriched the environment should prevent or ameliorate it. The Abecedarian intervention began in infancy because theory suggested that the early environment might more strongly affect cognitive development than that in later childhood (Hunt, 1961). This supposition was given credence by the relatively disappointing outcomes from intervention programs for disadvantaged children that began in the late preschool years (Cicirelli, 1969).

Families at risk for having a child showing developmental delays were identified from local prenatal clinics or social service agencies, and invited to enroll in the study. The research was a prospective longitudinal experiment to learn the degree to which the course of children's cognitive development might be positively altered. The intervention was primarily child-focused, delivered in a day care setting.

One hundred-nine qualified families were recruited over a five-year period extending from 1972 to 1977. Fifty-seven children born to 55 of these families[1] were randomly assigned to the Experimental preschool treatment group (E); 54 families were assigned to the preschool Control group (C).

1. Siblings born 15 months apart were admitted to the E group and one mother in the E group delivered identical twins.

Table 1 summarizes demographic characteristics of the sample. It shows that very few of the study children were born to "intact" families consisting of both biological parents living together in their own home. Rather, the majority were born into multigenerational and/or female-headed households. The mothers tended to be young--one third were aged 17 years or younger at the time of the child's birth. Maternal age ranged from the early teens to the mid-forties. Maternal education varied from grammar school level to some post-high school training; the mean level was less than a high school education. Maternal IQs averaged approximately 1 S. D. below the national norm. The modal earned income in these families was none, and at the point of the target child's birth, approximately 45% of the sample was receiving public assistance. Race was not a factor in selection of the subjects, but because of the characteristics of the community where the study took place, 98% of qualified families were Black.

Insert Table 1 about here

Preschool Intervention: Children in the preschool Experimental group attended the educational daycare program from early infancy until they entered public kindergarten at age five. Mean age of entry into the preschool program was 8.8 weeks. Curriculum materials to enhance the children's cognitive, language, perceptual-motor, and social development were devised by Sparling and Lewis (1981). Items were assigned to infants and toddlers based on the curriculum developers' and teachers' assessments of child needs. Parents were encouraged to visit the nursery and preschool, and a variety of brief programs to provide information on parenting and other topics of interest were offered to them. Children in the preschool E group had at least two meals a day at the Center, assuring good nutrition. They also received primary medical care from doctors and family nurse practitioners at the Center.

The intervention program for older preschoolers strongly emphasized language development and pre-literacy skills. For most E children, a summer program designed to ease the transition to public school was offered just before they entered kindergarten.

To ensure adequate infant nutrition in both preschool groups, the Control group children were given free iron-fortified formula for the first fifteen months of life. Medical care comparable to that provided to E group children was available to C group children at local low-cost or free clinics. Supportive social work services by Abecedarian project staff were provided as required for families in both groups. Provision of these services increased confidence that any developmental differences observed in E and C children were due to the educational intervention rather than to possible dietary or health care advantages in the E group children.

The identical protocol of standardized measures, home visits, and laboratory studies of mother-infant interactions was applied to both preschool groups. All standardized testing took place at the Center with a parent present to give the infant or young child emotional support.

At the end of the preschool phase, the children's scores on standardized measures of intellectual development showed that the E group significantly outscored the C group at every point after 12 months of age. These results have been reported in a number of publications, including Ramey and Campbell, (1984), Ramey, Bryant, Campbell, Sparling and Wasik, (1988), Ramey, MacPhee, and Yeates, (1982), and Martin, Ramey, and Ramey, (1990).

School-age intervention: The preschool E and C groups were re-randomized on the basis of their four-year Stanford-Binet scores and half of each group was assigned to receive educational intervention for the first three years the child attended public school. The resulting 4-cell design, shown in Figure 1, permitted a comparison of outcomes in children who had a total of 8 years of intervention, 5 in preschool with a follow-through of 3 years in

early elementary school (EE), 5 years of intervention in preschool only (EC), 3 years of school-age intervention only (CE), and no educational intervention at all (CC).

Insert Figure 1 about here

Ninety-six of the original 111 children remained available for assignment to a school-age intervention group. However, three children randomly assigned to the CE group left the area just before they entered public school and did not receive the planned intervention, reducing the number of possible subjects available for 4-group analyses to 93.

The rationale for the school-age intervention was that high-risk children might benefit from extra practice with basic reading and mathematics skills and from increased parent involvement in their education (Epstein, 1984). Accordingly, Home School Teachers (HSTs) designed individualized curriculum activities, coordinated with reading and math concepts being covered in the class, for delivery to the home. Parents were shown how to use these materials to reinforce the children's classroom learning. In addition, the HST advocated for the child and family within the school system and for the school system within the home.

In a typical year, approximately 60 different learning activities were provided each child. Parents generally accepted the program enthusiastically, and reported spending an average of 15 minutes a day working with their child at home. Many parents expressed regret that the program ended after only three years.

Child IQ and academic outcomes were measured at the completion of three years in public school, when all intervention ceased. As Figure 2 shows, a different trajectory of intellectual developmental was found for the two preschool groups across the longitudinal span from infancy to eight years. The Group X Time interaction term indicated that the preschool E group significantly outscored the preschool C group across the interval from 6 to

96 months of age $F_{(3,85)} = 7.37, p < .0002$. The greatest absolute difference between the groups (16 IQ points on the Stanford-Binet) occurred at 36 months; thereafter, there was a gradual rise in the mean IQ scores of the C group which narrowed the difference in the mean IQs of the two groups. At 96 months, the absolute difference in Full Scale IQ, as measured by the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974) was 4 1/2 points. The group difference in Verbal IQs of the two preschool groups approximated statistical significance at that point ($F_{(1,86)} = 3.93, p < .051$) but not the Performance IQs. The school-age phase of intervention had no detectable effects upon the children's intellectual test scores.

Insert Figure 2 about here

Prevention of scholastic failure is the ultimate goal of early interventionists, thus the differences in academic outcomes in the various groups are particularly important. After three years in public school, a significant multivariate relationship was found between the amount of intervention children had received and their academic achievement in reading and mathematics, whether achievement was measured by age-referenced or grade-referenced norms ($F_{(4,76)} = 3.32, p < .02$). Univariate analysis of the four groups' mean Age-referenced Standard Scores for Reading and Mathematics from the Woodcock-Johnson Pyschoeducational Battery (Woodcock & Johnson, 1977) showed significant linear trends, with the mean scores increasing as a function of the number of years of intervention. Also, consistent with the outcome reported by Lazar, Darlington, Murray, Royce and Snipper (1982), the likelihood of retention in grade was greatly reduced for Abecedarian subjects who had intervention. These results are presented in more detail in Ramey and Campbell (in press), and Horacek, Ramey, Campbell, Hoffmann, and Fletcher (1987).

Follow-up study: Four years after all intervention ceased, when the study subjects had completed seven years in public school and were approximately 12 years old, a follow-up study was conducted to learn how lasting the earlier positive intellectual and academic effects proved to be. The follow-up was modeled on Walberg's (1984) theory of educational productivity, which postulates that student aptitude, the amount and quality of instruction, and the home, classroom, and peer environments all influence affective, behavioral, and cognitive outcomes. Ninety of the 93 subjects taking part in the earlier phases of intervention were available for follow-up testing. Standardized tests of intellectual ability and academic achievement were individually administered to all subjects in the summer after completion of the seventh year in school by examiners unaware of the student's intervention history.

RESULTS

Figure 2 extends the developmental functions for intellectual test scores to age 12 for subjects in the preschool E and C groups. Unlike the general conclusion reached by investigators in the Consortium for Longitudinal Studies that early intervention produced IQ score differences that are "not permanent" (Lazar, et al., 1982, p. 47), we found that the effects of Abecedarian preschool intervention on measured IQ, particularly Verbal IQ, were still apparent at age 12.

Table 2 gives the 12-year mean Verbal, Performance, and Full Scale IQs for the four school-age groups as measured by the Wechsler Intelligence Scale for Children-Revised and Figure 3 graphs the Full Scale IQs, illustrating that the IQ advantage seen at this age is associated with preschool intervention, not the school-age program. A 2 (Preschool groups) x 2 (School-age groups) analysis of variance confirms a significant effect on mean Full Scale IQs attributable to Preschool Group assignment, with the preschool E group outscoring the preschool C group ($F_{(1,86)} = 5.59, p < .03$) and a similar finding for the Verbal IQ ($F_{(1,86)} = 7.62, p < .007$). There were no group differences in the Performance IQ.

Insert Table 2 and Figure 3 about here

As may also be seen in Figure 2, high-risk subjects in both the preschool E and C groups do show some decline in mean IQ from the preschool years to age 12. The relative difference between the groups remains, however, and in fact, is slightly more statistically significant at age 12 than at age 8.

As to the efficacy of the early educational program as a preventive measure against mild retardation, the results at age 12 suggest a positive effect. No child in the E group earned an IQ score of 70 or below; 3 children in the preschool C group did so. The likelihood of a child scoring in the Borderline range (IQ of 71-85) or lower is significantly greater for children in the preschool C group, Chi Square $_{(1)}$ = 12.19, $p < .0005$. Table 3 shows the numbers and percentages of the preschool groups who scored within the Normal range (IQ of 86 or higher) or Borderline range at age 12.

Insert Table 3 about here

Academic achievement was measured at age 12 using Age-referenced Standard Scores from the Woodcock-Johnson Pyschoeducational Battery (Woodcock & Johnson, 1977). Figures 4, 5, 6, and 7 give the results for the mean Age-referenced Standard Scores for Reading, Mathematics, Written Language and Knowledge across the four groups. For Reading, Written Language, and Knowledge a significant linear trend was found showing an increase in mean scores across the groups as years of intervention increases (p's $< .05$). The trend for Mathematics is similar, but did not attain the .05 level ($p = .076$). The conclusion is that effects of early intervention are still apparent at age 12 after the high-risk subjects have

been in public school 7 years. These data contrast with those reported by the Consortium for Longitudinal Studies which found the effects of early intervention on achievement in either reading or mathematics to have eroded by sixth grade (Lazar, et. al, 1982).

Insert Figures 4, 5, 6, and 7 about here

Figure 8 shows the percentage of children ever retained, by group, at the end of seven years in school. As was found at age 8, there was still found at age 12 a highly significant reduction in the likelihood of retention in grade for children who had preschool intervention (Chi Square$_{(1)}$ = 7.91, p = .0049). Over half the untreated preschool Controls, regardless of school-age treatment status, had been retained by the time they had been in school 7 years. In contrast, approximately one-fourth of the children with preschool intervention were retained during the same time period. This figure is similar to the 25% average figure for retention among treated children reported by the Consortium (Lazar, et al, 1982). To put the 25% retention rate in context of the local school system, it was found that, in a random sample of same-sex, same-age local peers of the Abecedarian subjects, the majority of whom were not at risk for academic failure, 18% had repeated a grade at the same point.

Insert Figure 8 about here

It is worth noting here that, although retention in grade is widely accepted as a valid indicator of scholastic difficulties, it is not a perfect index. In monitoring the Abecedarian children's school progress across 7 years, it developed that some who repeated were subsequently moved up and placed back on grade level. Children who moved from one system to another were likely to be placed in age appropriate classes in the new setting

regardless of prior retention decisions in other schools. Moreover, a few children who fell far behind academically were never retained because of other considerations such as child age, large physical size, or placement in resource programs.

Other outcomes: As part of the follow-up study, parents completed the Child Behavior Checklist and Profile (Achenbach & Edelbrock, 1983) describing their children's social adjustment, school progress, and problem behaviors, and the children described themselves using Harter's Perceived Competence Scales (Harter, 1982).

The results showed that, if children had preschool intervention, their parents were significantly more likely to perceive them as competent students at the end of 7 years in school, $F_{(1,87)} = 10.15, p < .002$. However, there were no group differences associated with intervention history in ratings of the 12-year-olds' social adjustment or in problem behaviors, either externalizing or internalizing.

It is interesting that the children's self perceptions of academic competence, as measured by the Harter, are not congruent with their parents' Child Behavior Checklist ratings of their scholastic progress. In fact, children with the most early intervention (eight years across preschool and early elementary school, the EE group) and those with no intervention at all (CC) rated themselves lowest in Cognitive Competence on the Harter, whereas those in the CE group, whose actual group mean IQ at age 12 is lowest of the four, rate themselves highest of all the groups on this variable.

CONCLUSIONS

1. Significant positive effects of the Abecedarian preschool intervention on children's intellectual test performance were found to persist through the age of 12 years. Although there had been a slight decline from the level of IQ scores seen earlier, the group IQ difference associated with preschool intervention not only persisted, but appeared stronger at age 12 than it did at age 8.

2. Significant positive effects on academic achievement in reading, associated with preschool intervention, found at age 8, persisted through age 12. Significant positive effects of earlier intervention on achievement in written language, knowledge, and skills were also found at age 12.

3. The likelihood of retention in grade was greatly reduced in children who had preschool intervention.

4. Parent's perceptions of their children's school success were related to preschool intervention, and realistically so, since children who received this type intervention outscored preschool controls in academic accomplishments.

5. Child self-ratings of cognitive competence were not a function of intervention history and were not consistent with objective measures of IQ or academic outcomes.

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Table 1

Entry Level Demographic Data for Preschool Experimental and Control Families

Variable	Group Experimental (N=55)	Control (N=54)	Total (N=109)
Mean Maternal Age (yrs)	19.62 (3.87)	20.28 (5.77)	19.94 (4.89)
Mean Maternal Education (yrs)	10.46 (1.75)	10.00 (1.89)	10.23 (1.83)
Mean Maternal Full Scale IQ	85.49 (12.43)	84.18 (10.78)	84.84 (11.61)
Percent "intact" families	23%	26%	24%
Percent Black	96%	100%	98%

Table 2

Mean Wechsler Intelligence Scale for Children-Revised Verbal, Performance, and Full Scale IQs for Abecedarian Subjects at 12 Years of Age.

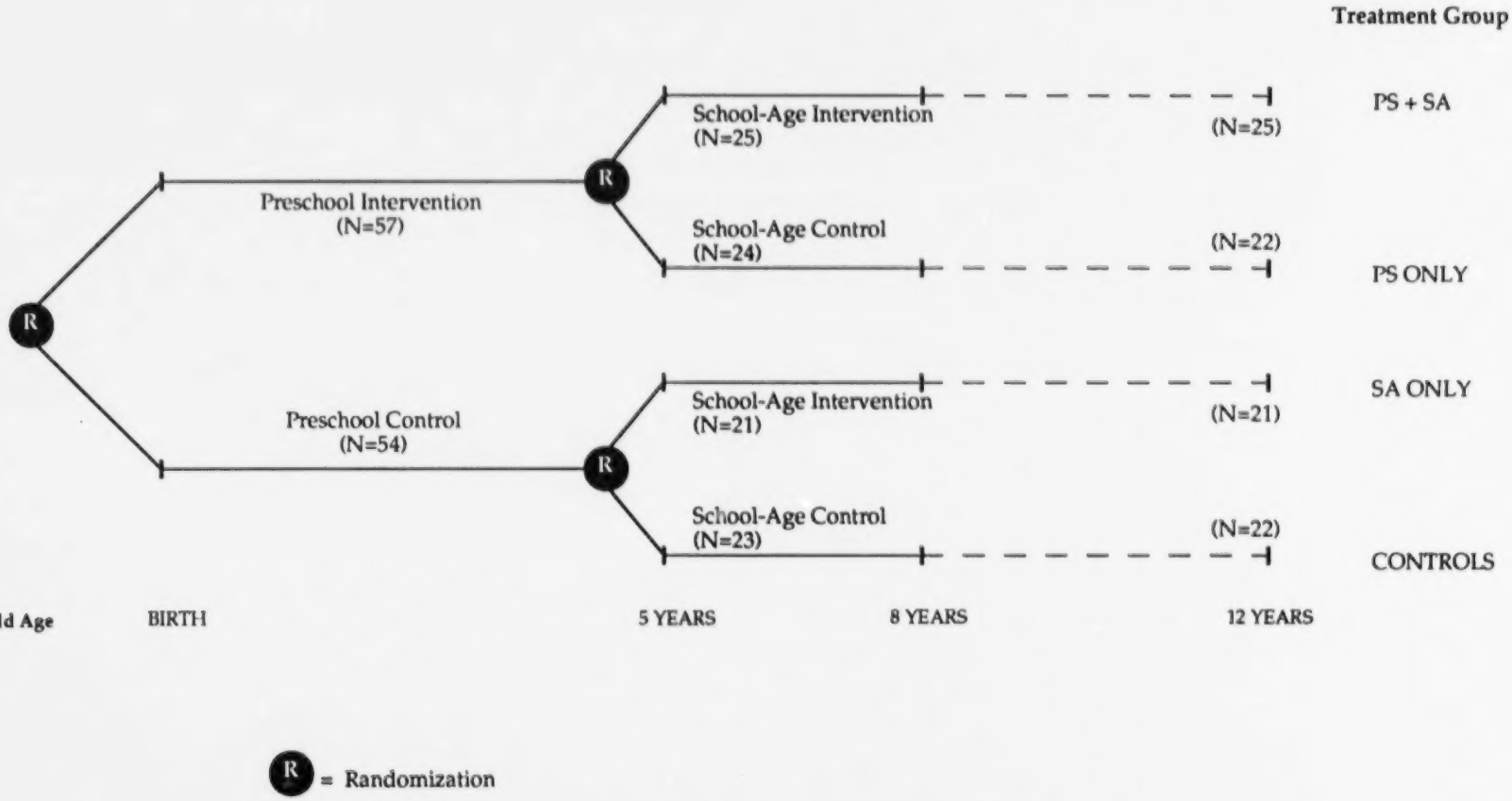
Group	N		IQ Score		
			Verbal	Performance	Full Scale
CC	22	M	84.64	96.55	89.14
		SD	8.68	15.78	10.92
CE	21	M	89.05	88.71	87.71
		SD	13.35	13.89	13.38
EC	22	M	93.27	97.14	94.23
		SD	9.98	9.79	8.29
EE	25	M	92.92	95.08	93.32
		SD	10.52	9.70	9.87
LPS	55	M	110.45	108.20	110.51
		SD	17.19	15.06	16.80
Preschool C	43		86.79	92.73	88.44
Preschool E	47		93.09	96.04	93.74

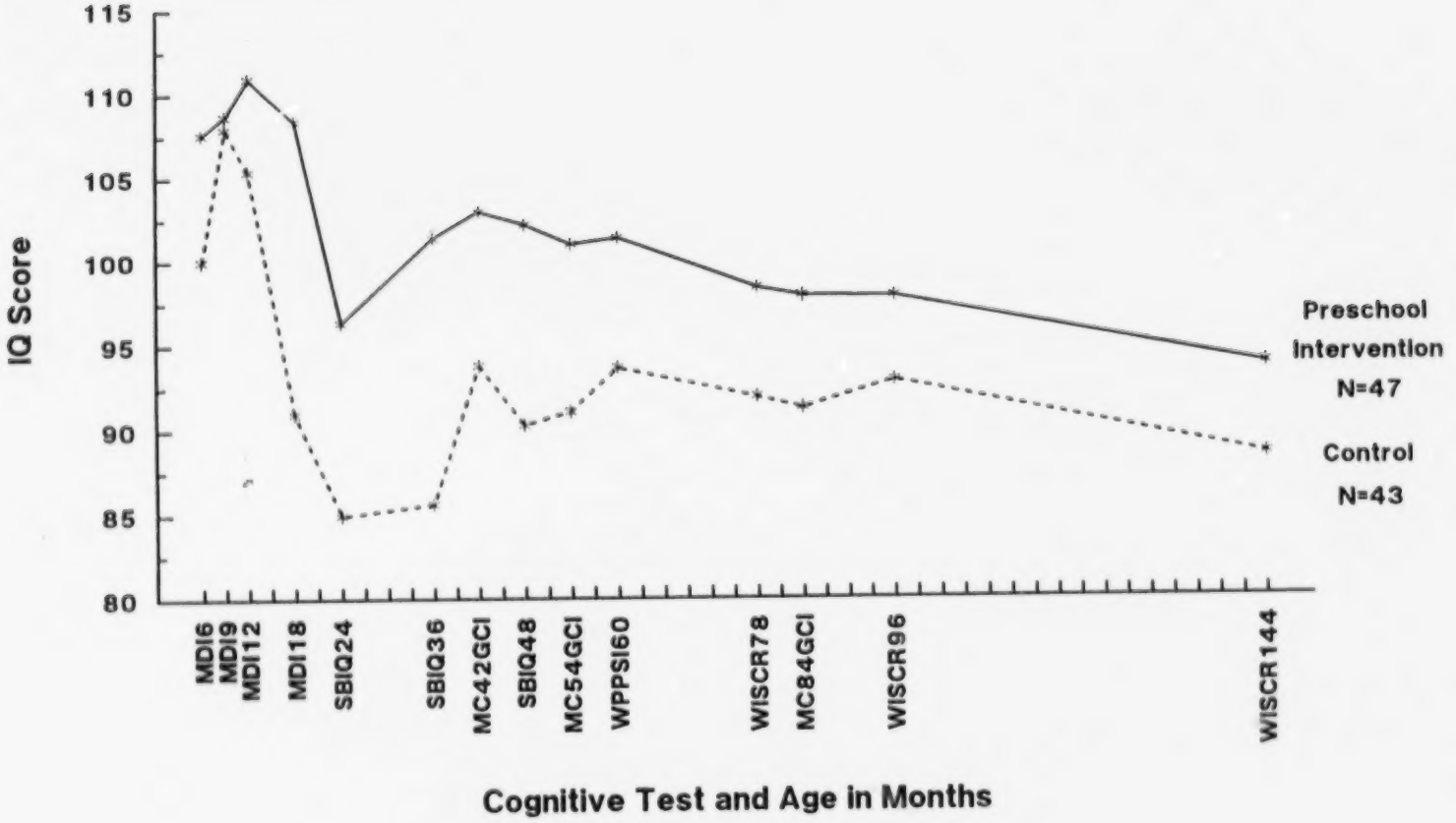
Table 3

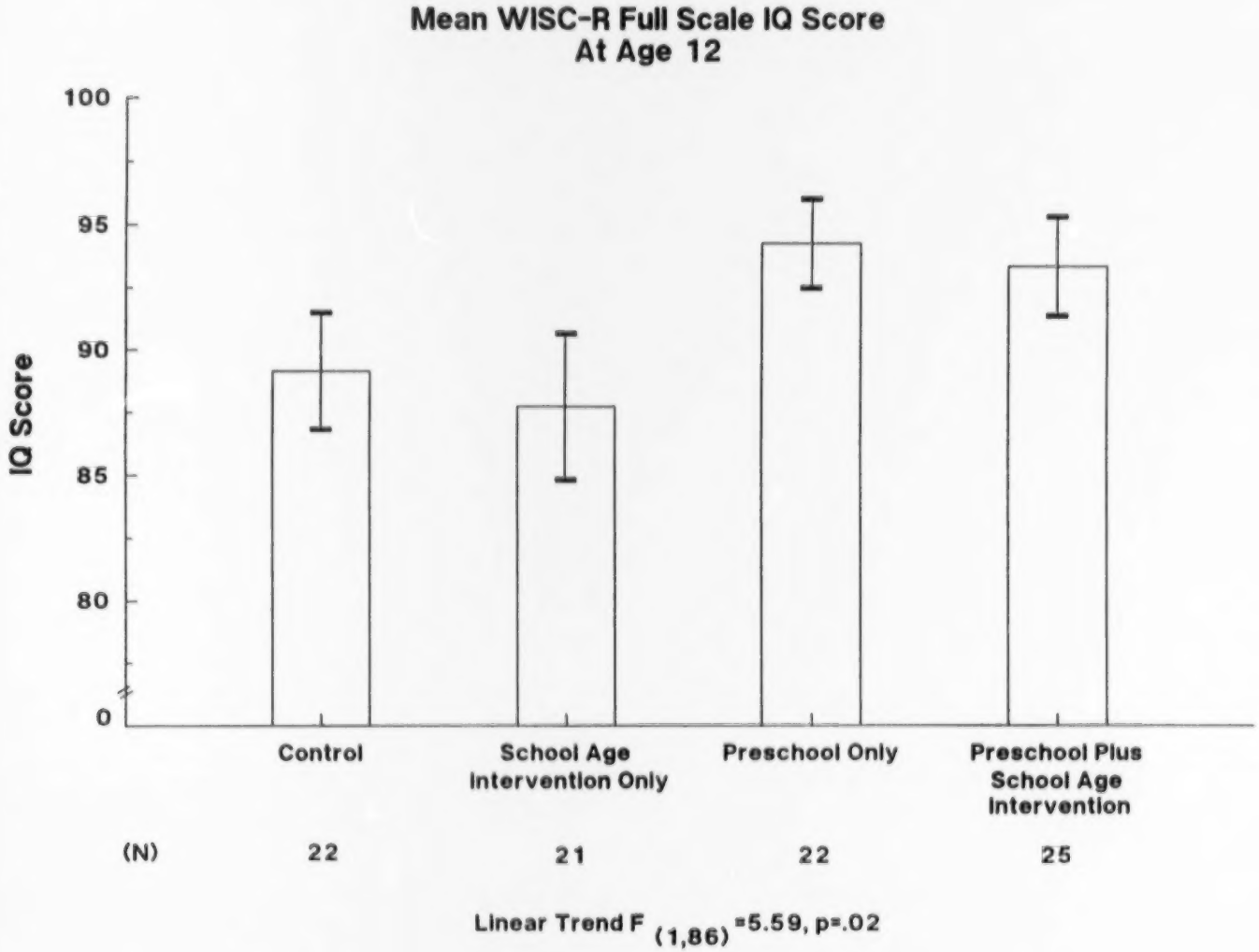
Numbers and Percent of Abecedarian Preschool Experimental and Control Groups Scoring in Borderline or Less and Normal IQ Ranges at Age 12

PRESCHOOL GROUP	IQ≤ 85	IQ≥ 86
E (N = 47)	N = 16 12.8%	N = 41 87.2%
C (N = 43)	N = 19 44.2%	N = 24 55.8%

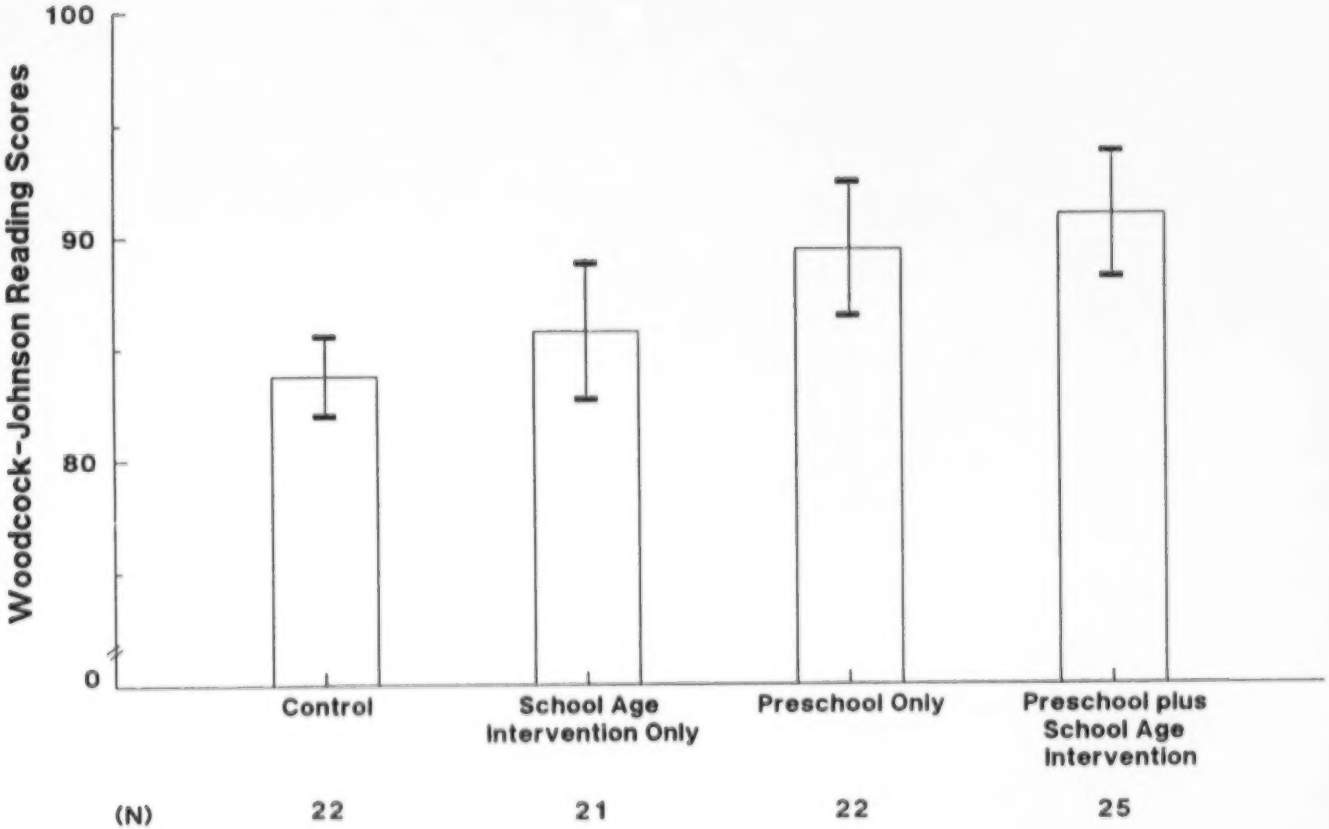
Study Design of Carolina Abecedarian Project



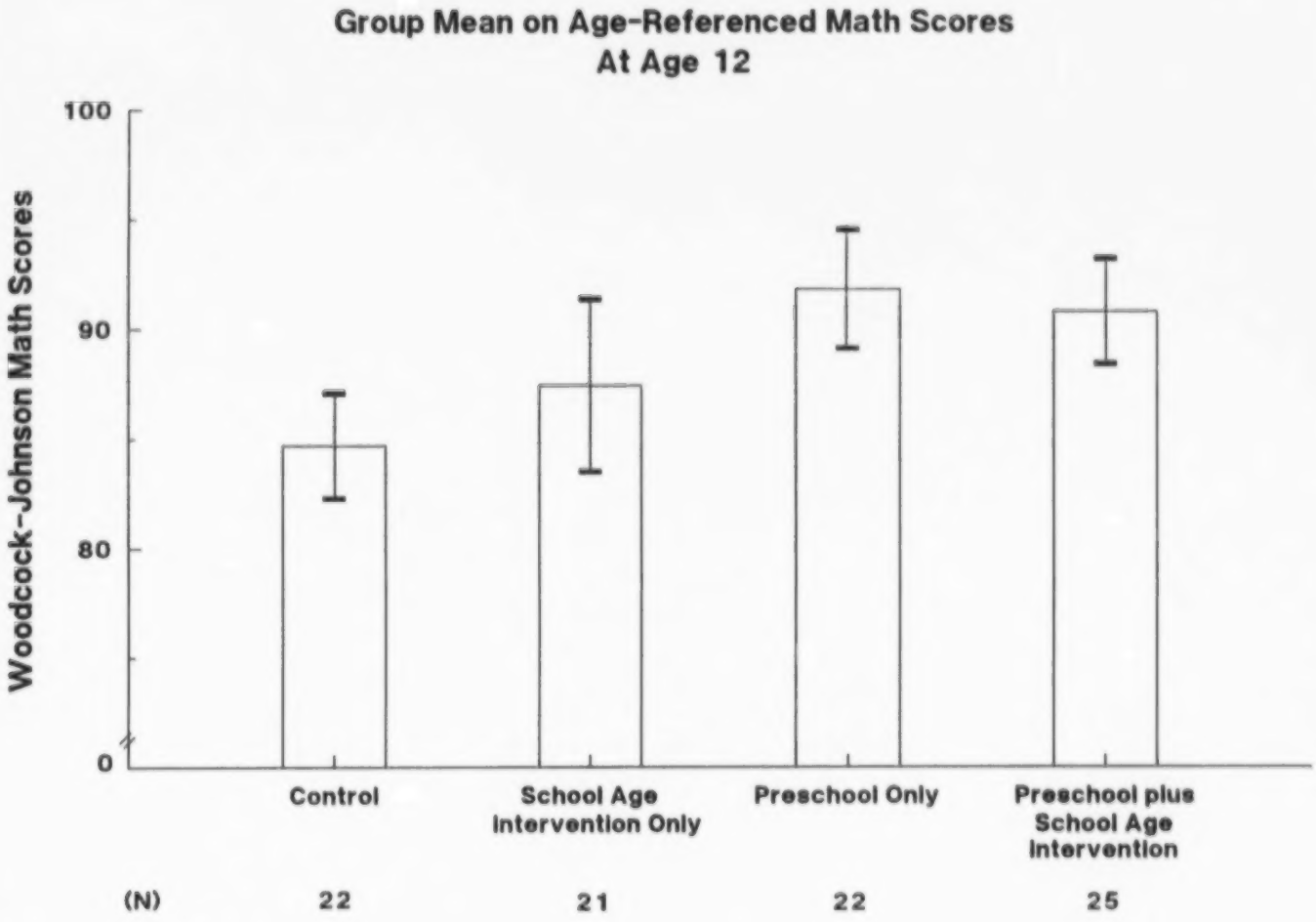

115
110
105
100
95
90
85
80
IQ Score
MDI6
MDI9
MDI12
MDI18
SBIQ24
SBIQ36
MC42GCI
SBIQ48
MC54GCI
WPPSI60
WISCR78
MC84GCI
WISCR96
WISCR144
Cognitive Test and Age in Months
Preschool
Intervention
N=47
Control
N=43

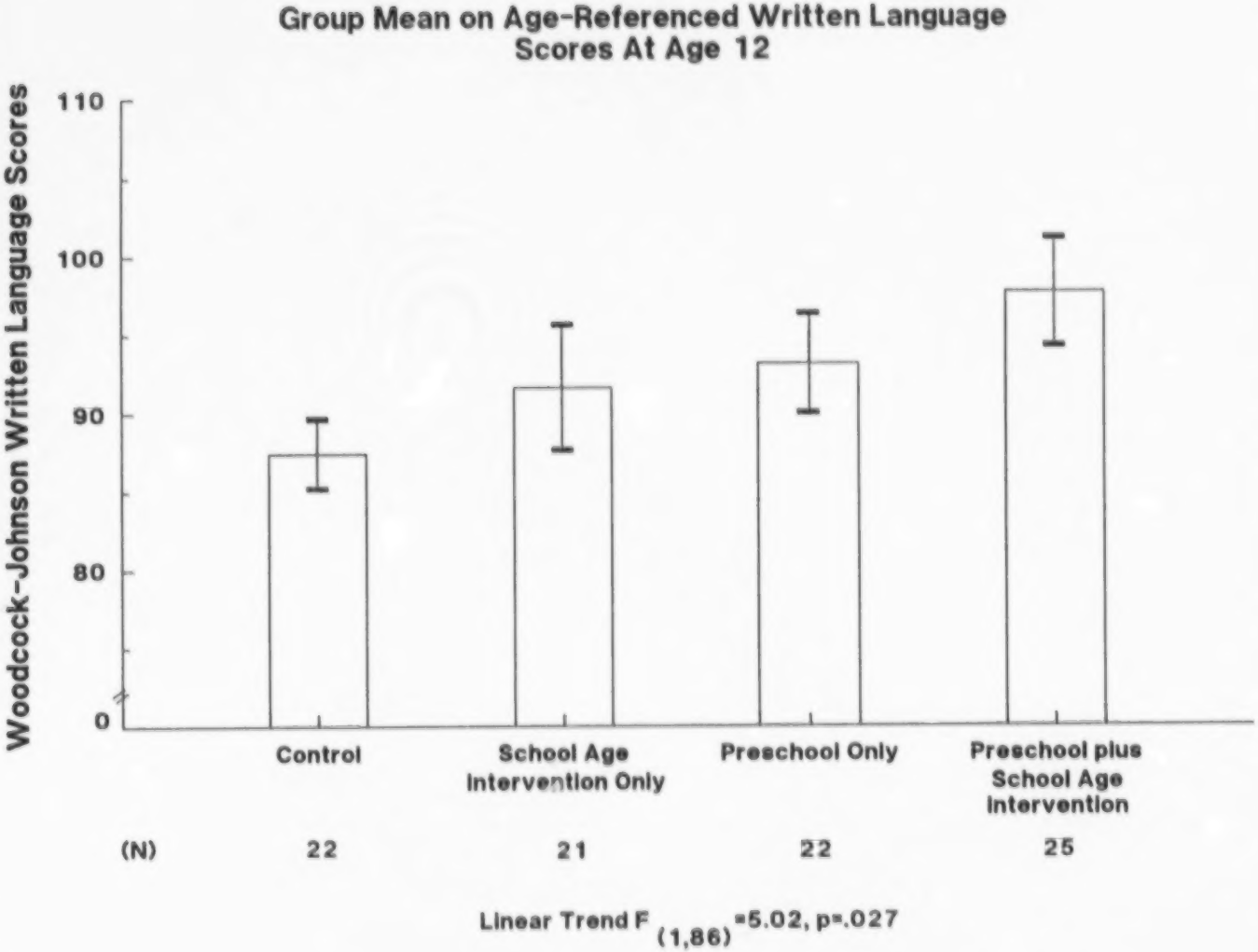

Mean WISC-R Full Scale IQ Score
At Age 12
IQ Score
100
95
90
85
80
0
Control
School Age Intervention Only
Preschool Only
Preschool Plus School Age Intervention
(N)
22
21
22
25
Linear Trend F (1,86) =5.59, p=.02

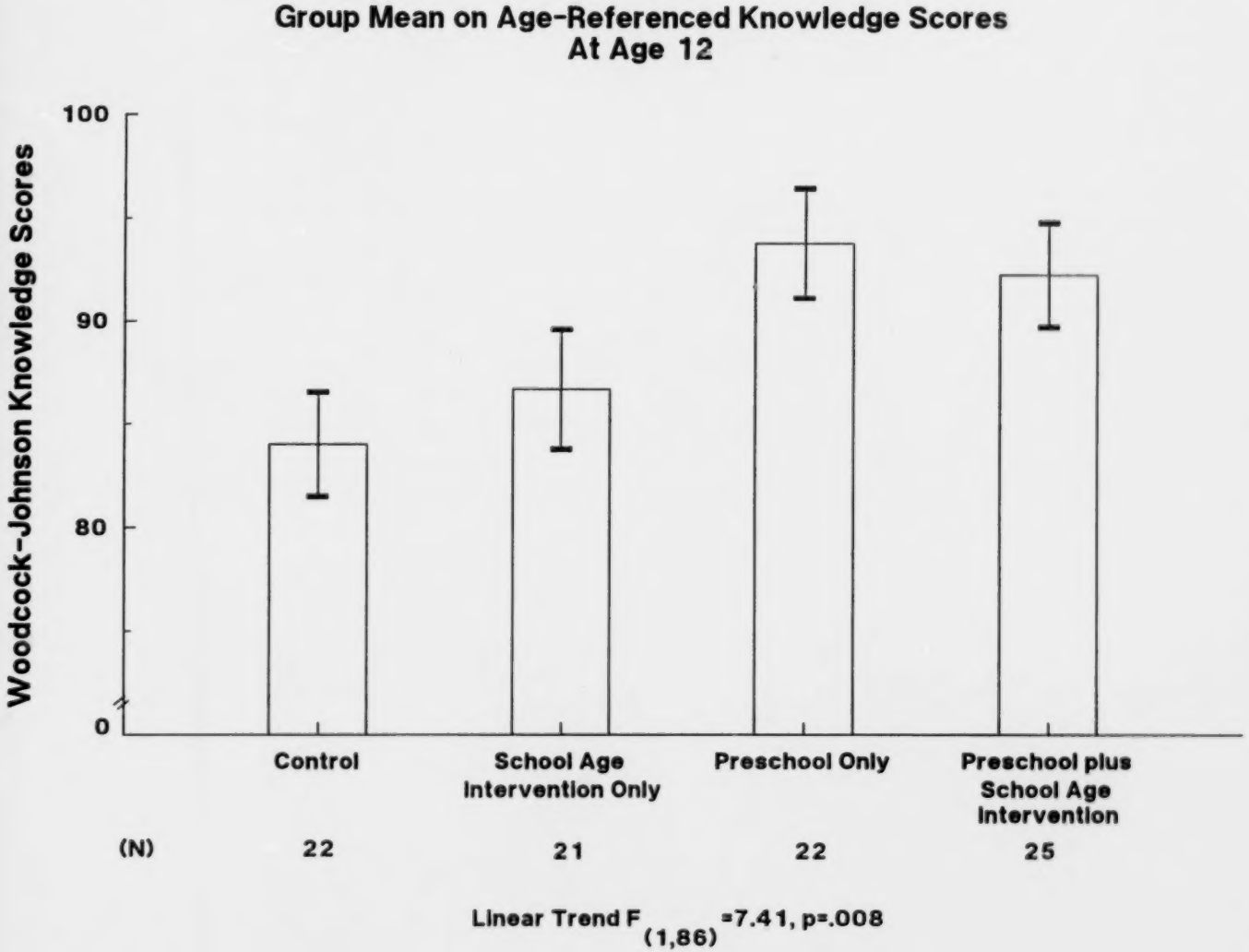
Group Mean on Age-Referenced Reading Scores At Age 12

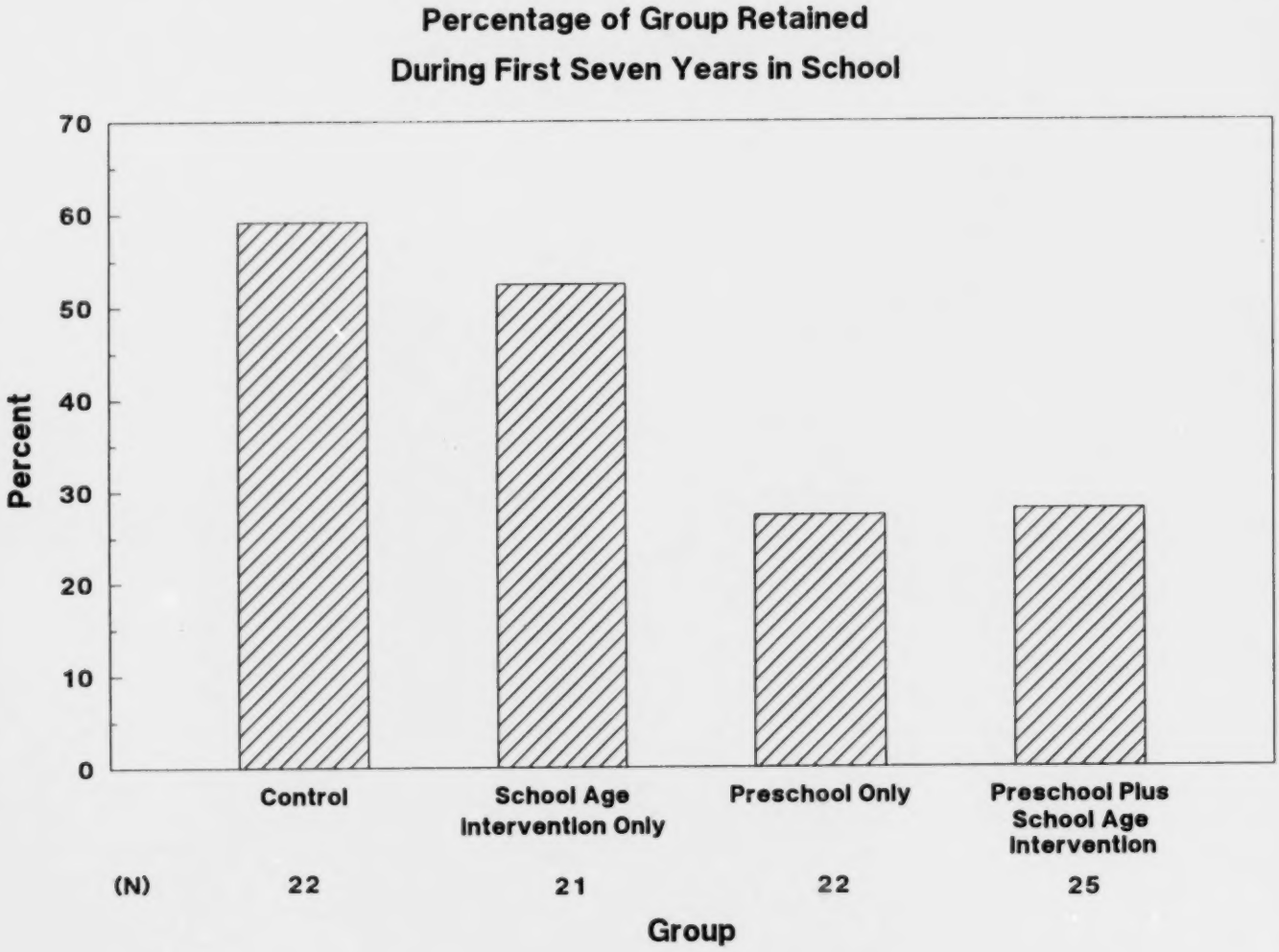


Linear Trend $F_{(1,86)} = 4.45$, $p = .038$


Group Mean on Age-Referenced Math Scores
At Age 12
Woodcock-Johnson Math Scores
100
90
80
0
Control
School Age Intervention Only
Preschool Only
Preschool plus School Age Intervention
(N)
22
21
22
25
Linear Trend F (1,86) =3.23, p=.076


Group Mean on Age-Referenced Written Language Scores At Age 12
Woodcock-Johnson Written Language Scores
110
100
90
80
0
Control
School Age Intervention Only
Preschool Only
Preschool plus School Age Intervention
(N)
22
21
22
25
Linear Trend F (1,86) =5.02, p=.027


Group Mean on Age-Referenced Knowledge Scores
At Age 12
Woodcock-Johnson Knowledge Scores
100
90
80
0
Control
School Age Intervention Only
Preschool Only
Preschool plus School Age Intervention
(N)
22
21
22
25
Linear Trend F (1,86) =7.41, p=.008



Preschool Effect $X^2_{(1)}$ =7.91, p=.005